VIRAL

Analysis of microscopic images by artificial intelligence

Boris Malčić

Faculty of Electrical Engineering, University of Banja Luka

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Introduction

- In image classification tasks, we assume that there is only *one* major object in the image and we only focus on how to recognize its category.

- There are often *multiple* objects in the image of interest. We not only want to know their categories, but also their specific positions in the image.

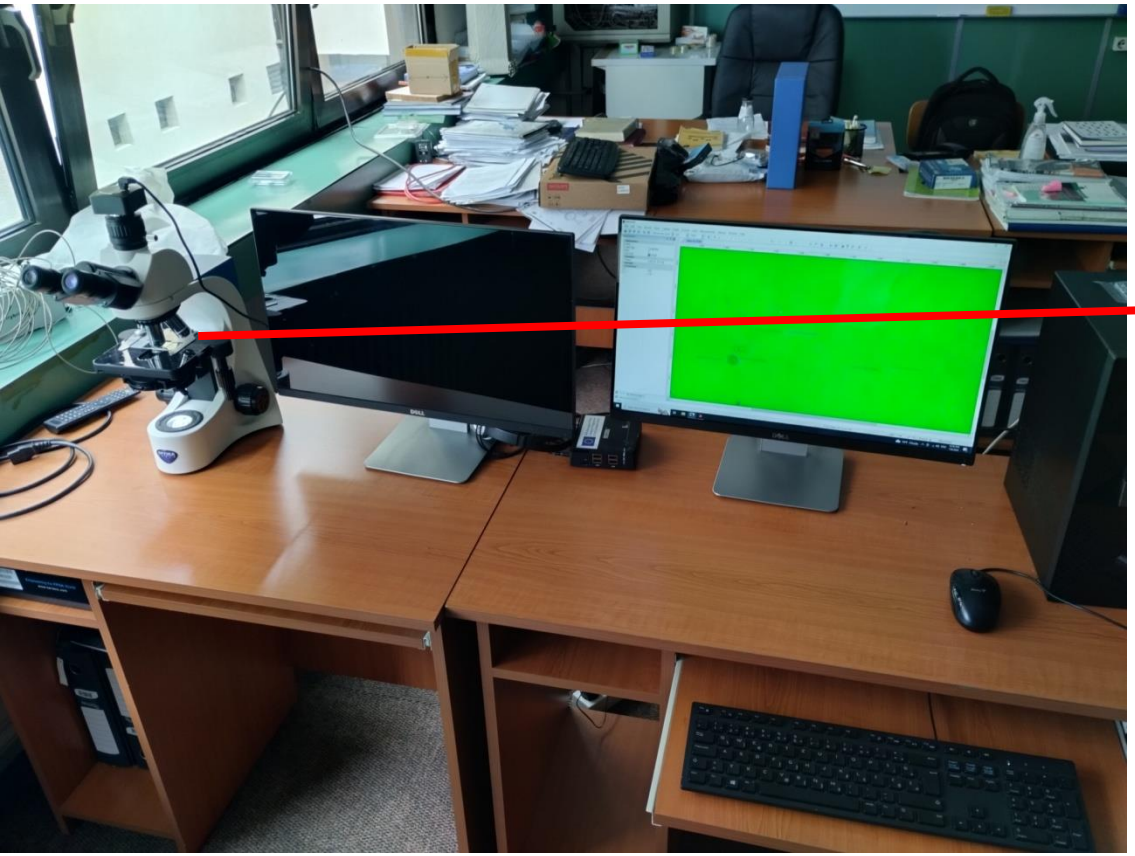
- In computer vision, we refer to such tasks as *object detection* (or *object recognition*).

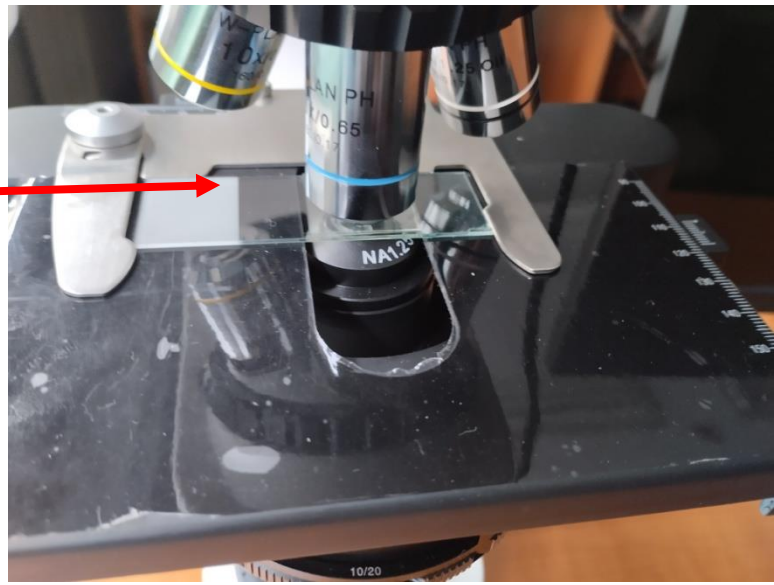
- Object detection has been widely applied in many fields:

self-driving needs to plan traveling routes by detecting the positions of vehicles, pedestrians, roads, and obstacles in the captured video images. Robots may use this technique to detect and localize objects of interest throughout its navigation of an environment. Security systems may need to detect abnormal objects, such as intruders or bombs.

- In the next few slides, we will introduce an **d**eep **l**earning (**DL**) YOLO method for object (nosema cell) detection and automatic counting in microscopic images.

1) Sample preparation

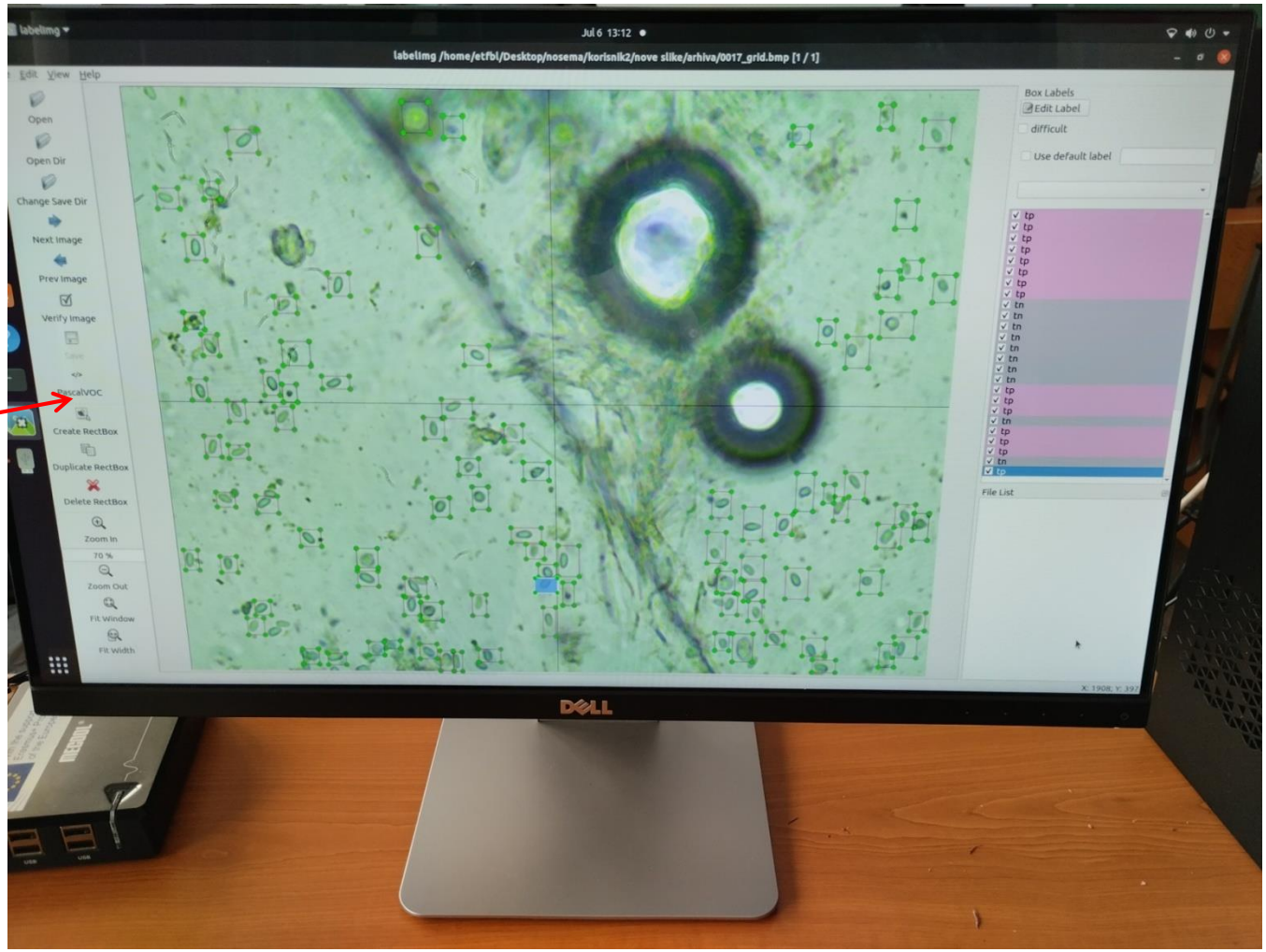




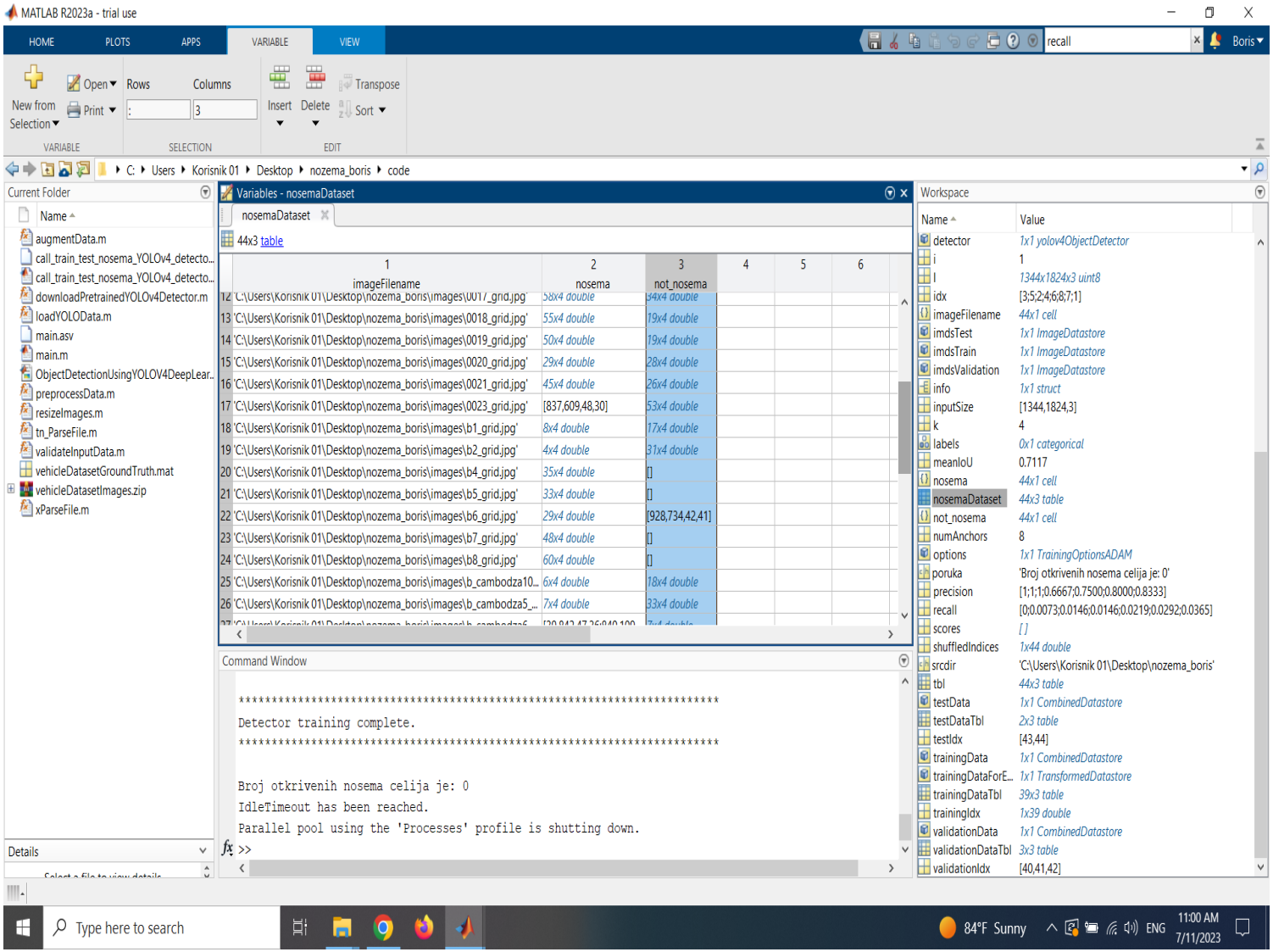
2) LabelImg

https://github.com/heartexlabs/labelImg

YOLO



3) Preparing dataset for training



4) Training

```
inputSize = [1344 1824 3]; %
className = "nosema";
numAnchors = 8; %  "tiny-yolov4-coco“ …
[anchors,meanIoU] = estimateAnchorBoxes(trainingDataForEstimation,numAnchors);
detector = yolov4ObjectDetector("tiny-yolov4-coco",className,anchorBoxes,InputSize=inputSize);
augmentedTrainingData = transform(trainingData,@augmentData);
montage(augmentedData,BorderSize=10)
options = trainingOptions("adam",...
GradientDecayFactor=0.9,...
SquaredGradientDecayFactor=0.999,...
InitialLearnRate=0.001,...
LearnRateSchedule="none",...
MiniBatchSize=1,...
L2Regularization=0.0005,...
MaxEpochs=10,... % take free to change the number of epochs for optimal solution
CheckpointPath=tempdir,...
ValidationData=validationData);

[detector,info] = trainYOLOv4ObjectDetector(augmentedTrainingData,detector,options);
```

4) Training (Transfer learning) using YOLO v4 model

The **Y**ou **O**nly **L**ook **O**nce **v**ersion **4** (**YOLO v4**) object detection network:

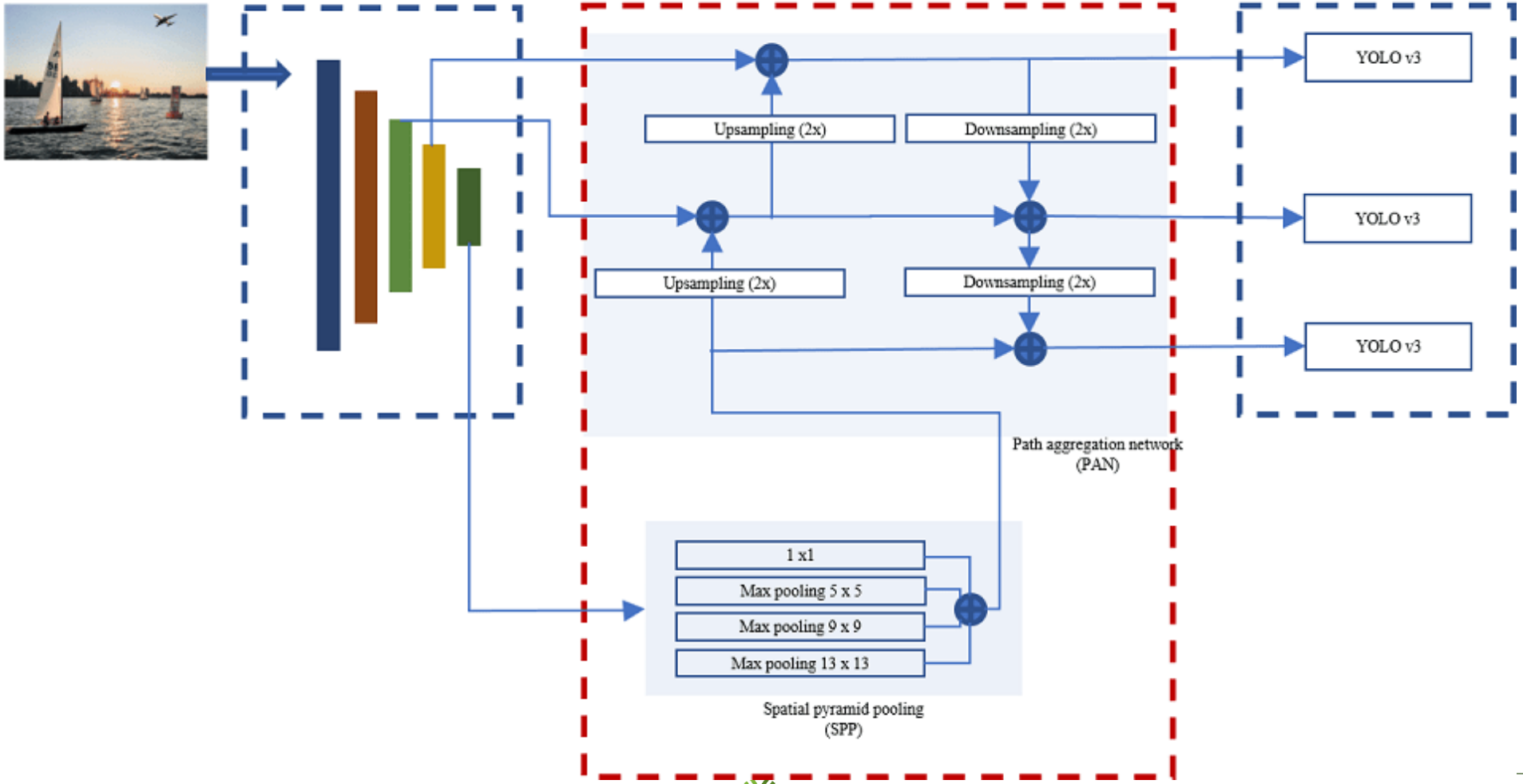
backbone, neck, and head.

The backbone can be a pretrained convolutional neural network such as CSPDarkNet53 trained on COCO or ImageNet data sets.
The backbone of the YOLO v4 network acts as the feature extraction network that computes feature maps from the input images.

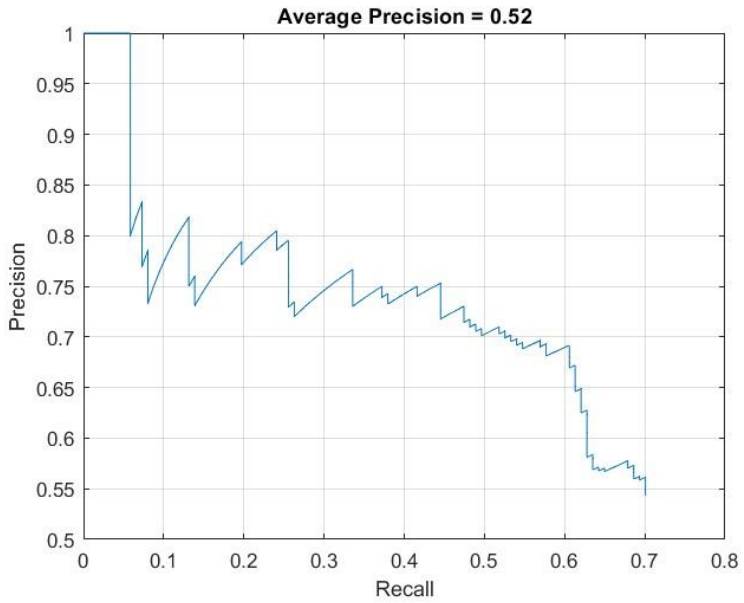
The neck connects the backbone and the head. Composed of a spatial pyramid pooling (SPP) module and a path aggregation network (PAN). Concatenates the feature maps from different layers of the backbone network and sends them as inputs to the head.

The head processes the aggregated features and predicts the bounding boxes, objectness scores, and classification scores. The YOLO v4 network uses one-stage object detectors, such as YOLO v3, as detection heads.

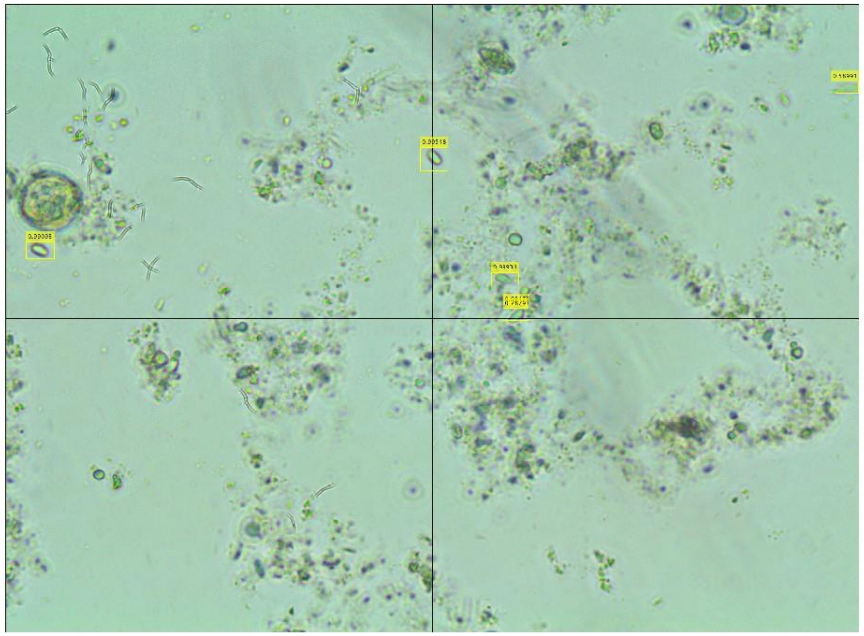
https://www.mathworks.com/help/vision/ug/getting-started-with-yolo-v4.html



5) Testing and validation of DL model for detection of nosema cells



After 60 epochs of training



Detection of nosema cells using our trained YOLO v4 DL model

Recall is a ratio of true positive instances to the sum of true positives and false negatives in the detector, based on the ground truth.

Precision is a ratio of true positive instances to all positive instances of objects in the detector, based on the ground truth.

For a multiclass detector, recall and precision are cell arrays, where each cell contains the data points for each object class.

Conclusion

- **The future belongs to intensive AI usage**
- **Future "smart solutions", need "appropriate knowledge"**
- https://www.youtube.com/watch?v=vT1JzLTH4G4&list=PLC1qU-LWwrF64f4QKQT-Vg5Wr4qEE1Zxk
- https://www.mathworks.com/help/vision/ug/object-detection-using-yolov4-deep-learning.html
- https://d2l.ai/chapter_preface/index.html
- https://www.deeplearningbook.org/

THANK YOU!

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VITALISING ICT RELEVANCE IN AGRICULTURAL LEARNING